C O R E - S A M P L I N G   G R E A S E   W O O L

F O R

F I N E N E S S   A N D   V A R I A B I L I T Y

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CORE-SAMPLING GREASE WOOL FOR FINENESS AND VARIABILITY

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INTRODUCTION

Research is being conducted by the Department of Agriculture to determine the feasibility of marketing wool on a quantitative description basis.

The fineness of wool and the range in fineness are among the major physical characteristics influencing its utility and value. The accurate determination of these characteristics requires laboratory analysis. Because of its bulk it is impractical to test an entire lot of wool; therefore, it is advantageous to test only a small sample. The accuracy of the analysis then depends largely upon the sample being representative of the entire lot. For this reason it is important that adequate methods of sampling be developed.

Recognizing the objectiveness of the core-sampling method for determining the amount of clean wool which can be obtained from a given lot of grease wool, the Wool Standards Laboratory, in 1950, initiated a study of the adequacy of using samples drawn by the core-boring method for determining fineness and fineness variability of grease wool.

One of the first considerations in using cores to determine the fineness of a lot of wool was to investigate the homogeneity of the composite core sample, which is an accumulation of a number of cores blended into a mass of fibers by dusting or subsampling, or both, and by scouring operations. To this end the Wool Standards Laboratory, in cooperation with various interested organizations, conducted tests on the sampling problem.

Preliminary work relating to this question was reported by von Bergen and Wolf of the Forstmann Woolen Company 2/. They tested samples of 1/2-inch cores drawn from three lots of grease wool. Results for fineness and variability showed the samples to be quite homogeneous, with no significant difference between subsamples selected by taking 20 grabs of the fibers from the composite core sample.

Some of the first work of this nature was described in a report, "Progress in Fineness Determination, 1941-44," by the American Society for Testing Materials, Committee D-13 on Textiles (1) 3/. Additional work was reported in 1950 by the A.S.T.M., Committee D-13 on Textiles, Subcommittee

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1/ The Livestock Division Wool Laboratory is located at Denver, Colo.

2/ Private communication, February 27, 1950.

3/ Underscored numbers in parentheses refer to Literature Cited, page 17.

on Wool Fineness (2). Measurement of the fineness of fibers of wool core samples was studied in an interlaboratory test on two lots. The samples were composites of a number of cores of grease wool extracted by means of a 1/2-inch-diameter tube. Scouring operations formed each group of cores into a composite sample, from which the samples for measurement were taken. Twenty-three laboratories, consisting of commercial testing companies, mill laboratories, U. S. Department of Agriculture laboratories interested in wool, and State experiment station wool laboratories, participated in the study. Results of this interlaboratory test showed that most of the differences that were found were laboratory differences and not differences in material measured at each laboratory.

Results of these preliminary tests indicated that the composite core samples tested were homogeneous. With this point established the next step was to ascertain whether the core sample could be relied upon to give an accurate estimate of the fineness and variability of a lot of grease wool.

A report on the relationship of fineness in wool top, noil, card sliver, and grease wool, by Pohle and others (7), describes two methods of sampling grease wool. One consists of drawing hand samples at random from a pile of matchings after the blends are made and just prior to scouring and processing into top. The second method involves the use of scoured subsamples of 3-inch core samples which have been drawn according to regular practice from the grease wool for clean yield determinations. The fineness results of the card sliver samples were used as a control check on the sampling adequacy for the grease wool. It was concluded that the differences found in average diameter between card sliver and grease wool were smaller when using cores than when hand drawn samples were used.

Wakelin and von Bergen (8) in the Final Report of the Wool Research Project, submitted to the Department of Agriculture, state that the core-boring method of sampling raw wool proved to be a reliable method for predicting the fineness of wool prior to mill processing.

It was apparent from these preliminary studies that core sampling had promising possibilities as an objective sampling method for determining the fineness and variability of a lot of grease wool; however, certain problems came up and these were made the major objectives of the present study. The objectives were (a) to determine if the size of coring tube used in drawing cores influenced fineness results, (b) to develop a reliable and economical plan for subsampling scoured core residues, and (c) to determine the adequacy of cores drawn for clean yield determinations as samples for estimating the fineness and variability of a lot of graded grease wool.

MATERIALS USED

The core samples analyzed in this study were drawn with the $1\frac{1}{4}$-inch and 3/8-inch coring tubes. The samples were obtained from three lots of grease wool which were processed into wool top. Lot 1 was 64s staple in grade and consisted of 26 bales weighing 10,606 pounds. Lot 2 was 56/58s staple and

was made up of 14 bales weighing 5,689 pounds. Lot 3 was 48/46s staple and included 2 bales totaling 831 pounds.

The samples representing the card sliver were taken during the carding operation at the processing mill.

METHODS AND PROCEDURES

Procedure for core-sampling bales.—Ten bales from the 64s staple lot and 10 bales from the 56/58s staple lot were selected for coring. There were only two bales in the 48/46s staple lot and both bales were cored.

All cores were drawn from the seam edges of the bale cover on both ends of each bale.

Three series of cores were taken from each bale selected for coring.

The first series consisted of cores taken with the 3/8-inch pressure tube and referred to in this study as composite 3/8-inch pressure cores. Ten cores per bale were drawn from the 64s staple lot, 8 cores per bale from the 56/58s staple lot, and 8 cores per bale from the 48/46s staple lot.

The second series of cores was also drawn with the 3/8-inch pressure tube. Five cores per bale were drawn. Each core was packaged individually and identified by bag number. The cores in this series are called individual 3/8-inch pressure cores.

The third series of cores was extracted with the $1\frac{1}{4}$-inch motor-driven coring tube. This series of cores is referred to as composite $1\frac{1}{4}$-inch cores. Ten cores per bale were drawn from the 64s staple lot, 8 cores per bale from the 56/58s staple lot, and 8 cores per bale from the 48/46s staple lot.

Sample preparation.—The composite 3/8-inch pressure core samples and the composite $1\frac{1}{4}$-inch cores were scoured by standard aqueous scouring procedures to determine percentage clean yield. Residual scoured wool from these samples was used in making fineness and variability determinations. Each individual 3/8-inch pressure core was scoured in an aqueous solution of detergent and soda ash and rinsed, before fineness measurements were made.

Subsampling composite 3/8-inch pressure cores.—Two plans were used in subsampling these scoured cores.

Plan I. A handful of fibers of approximately 7 grams was selected at random from the residual scoured core sample. From the bulk of this 7-gram sample small quantities of fibers were drawn at random until an amount was reached which filled a large cross-section device. A test specimen prepared from this plan was then measured for fiber fineness and variability. The term test specimen, as herein referred to, applies to the wool fibers of the approximate length of 200 microns that have been sliced from the fiber bundle

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extruded from the large cross-section device, and subsequently thoroughly dispersed in mineral oil on a glass microscope slide, fixed with a cover glass preparatory to the actual measurement of the fineness of the fibers.

Plan II. The residual sample of scoured cores was divided into 60 zones. From each zone only enough fibers were drawn so that the accumulation of draws from each zone would fill the large cross-section device. The test specimen was then measured for fineness and variability.

Subsampling composite 1¼-inch cores.—Two plans were used in subsampling the residual scoured wool from the composite sample of 1¼-inch cores.

Plan I. In this plan the residual scoured wool was compressed into a cylinder 3 inches in diameter. Cores were extracted from the compressed sample by using the 3/8-inch pressure coring tube (figs. 1 and 2). After each core was drawn the remaining wool was removed from the cylinder, blended, and repacked into the cylinder before another core was drawn. This operation was repeated until a subsample of 7 grams was secured. From this subsample small quantities of fibers were drawn at random until a sufficient amount was obtained to fill the large cross-section device. A test specimen for fineness and variability measurement was prepared from the wool in the device.

Plan II. As in Plan I the residual scoured wool was compressed into a cylinder 3 inches in diameter, and cores were extracted by using the 3/8-inch pressure coring tube. However, Plan II deviates from Plan I in that each core was kept separate. Six individual cores were drawn from the sample representing the 64s staple lot, ten individual cores from the 56/58s staple lot, and ten from 48/46s staple lot. As much of the individual core as possible was placed in the large cross-section device. In this manner test specimens for fineness and variability were prepared for each individual core.

Subsampling individual 3/8-inch pressure cores.—Each of the scoured individual 3/8-inch pressure cores was considered to be a subsample. Individual cores were packed into the large cross-section device and test specimens were prepared for fineness and variability measurement.

Subsampling card sliver.—Six slivers were used to represent the carded wool from the 64s staple lot. Ten slivers were used from the 56/58s staple lot and ten from the 48/46s staple lot. Test specimens were prepared for fineness and variability measurements from each sliver by using the large cross-section device.

Measurement method.—The method of measurement of the wool fibers for fineness and variability followed very closely the procedure described by A.S.T.M. for the short-fiber method (3).

For all individual cores and individual card slivers 100 fibers per test specimen were measured.

From 600 to 1,000 fibers per test specimen were measured for the subsamples from the cores which were homogenized into a composite sample.

Figure 1.-Equipment used in subsampling composite 1¼-
inch scoured cores. A. Scoured wool compressed into
a cylinder 3 inches in diameter. B. Pressure coring
tube with 3/8-inch cutting tip, pushed into the com-
pressed wool with a quick thrusting motion.

Figure 2.-Extruding cores. A. Inserting rod into tube
through the cutting tip. B. Core being extruded
from tube.

RESULTS AND DISCUSSION

Fineness and variability measurements were made on test specimens pre-
pared from core samples drawn from bales selected from three lots of graded
grease wool. Three procedures for core-sampling the bales were used. Dif-
ferent plans of subsampling the composite scoured core samples were tested.
Card sliver samples representing carded wool from each lot were also measured
for fineness and variability. The data in table 1 are the average fiber
diameter, standard deviation, and coefficient of variation for scoured core
samples summarized by subsampling plan, and procedures for core-sampling
according to grade of lot; also included are number of bales cored, number
of cores drawn per bale, total number of fibers measured, and card sliver
measurements.

Table 1.- Average fiber diameter, standard deviation, and coefficient of
variation for scoured core and card sliver samples of wool

Grade of lot	Number of bales cored	Number of cores drawn per bale	Procedure for core sampling	Plan of subsam- pling	Number of fibers measured	Average fiber diameter	Stand- ard devia- tion	Coeffi- cient of vari- ation
						Microns	Microns	Percent
64s staple	10	10	Composite 3/8"	I	600	21.78	4.80	22.04
				II	600	21.40	4.63	21.64
	10	5	Individual 3/8"		5,000	21.76	5.05	23.21
	10	10	Composite 1¼"	I	600	21.70	4.85	22.35
				II	600	21.70	4.71	21.70
	Card sliver				600	21.90	4.63	21.14
56/58s staple	10	8	Composite 3/8"	I	1,000	26.35	6.53	24.78
				II	1,000	26.58	6.80	25.58
	10	5	Individual 3/8"		5,000	26.61	6.70	25.18
	10	8	Composite 1¼"	I	1,000	26.98	5.80	21.50
				II	1,000	26.50	6.48	24.45
	Card sliver				1,000	26.60	6.33	23.80
48/46s staple	2	8	Composite 3/8"	I	1,000	31.80	7.25	22.80
				II	1,000	32.38	7.63	23.56
	2	5	Individual 3/8"		1,000	32.40	7.55	23.30
	2	8	Composite 1¼"	I	1,000	32.30	8.05	24.92
				II	1,000	32.25	7.38	22.88
	Card sliver				1,000	32.12	7.71	24.00

Comparison of fineness obtained by using 3/8-inch pressure coring tube
and 1¼-inch coring tube.--Presented in table 2 is a comparison of the fine-
ness of samples drawn with the 3/8-inch pressure coring tube and the 1¼-inch
coring tube to determine if size of tube used in drawing cores influenced the

fineness results. The differences in the average fiber diameters were computed. The differences were tested for significance by using the Student "t" test.

Table 2.- Comparison of average fiber diameter of samples of wool drawn with 3/8-inch pressure coring tube and $1\frac{1}{4}$-inch coring tube, by grade

Grade of lot	Size of coring tube	Average fiber diameter	Difference in average fiber diameter	t [1]
		Microns	Microns	
64s staple	Composite 3/8" Composite $1\frac{1}{4}$"	21.59) 21.70)	0.11	0.80
56/58s staple	Composite 3/8" Composite $1\frac{1}{4}$"	26.46) 26.74)	.28	1.38
48/46s staple	Composite 3/8" Composite $1\frac{1}{4}$"	32.09) 32.28)	.19	.79

[1] A "t" value of 1.96 is significant at the 5-percent probability level.

The difference found in average fiber diameter between samples obtained by using the 3/8-inch pressure core and the $1\frac{1}{4}$-inch coring tube ranged from 0.11 micron to 0.28 micron. The "t" test did not detect a significant difference between the average fiber diameters of samples that were compared for fineness. Therefore, for the samples tested in this study the size of coring tube used in drawing cores does not appear to influence fineness results.

Experiment on subsampling.--The plans used in subsampling the composite samples of residual scoured cores were described previously under Methods and Procedures. Two plans were used in subsampling the composite residual 3/8-inch scoured cores, and two plans were used in subsampling the residual scoured wool from the composite sample of $1\frac{1}{4}$-inch cores.

The different subsampling plans were tested to see if the differences that exist between the average fiber diameters of subsamples were significant. The data in table 3 summarize this analysis.

The difference in average fiber diameter between subsampling plans I and II prepared from the composite residual 3/8-inch scoured cores averaged 0.40 micron and ranged from 0.23 to 0.58 micron. The "t" test did not detect any significant difference between average fiber diameter of subsamples that were compared for fineness.

For the composite residual samples of $1\frac{1}{4}$-inch cores the difference in average fiber diameters between subsampling plans I and II averaged 0.27 micron and ranged from no difference to 0.48 micron. There was no significant difference in fineness for subsamples according to the "t" test.

Table 3.- Differences in average fiber diameter of subsamples by procedure
for core sampling

Grade of lot	Procedure for core sampling	Plan of subsampling	Average fiber diameter	Difference in average fiber diameter	t [1]
			Microns	Microns	
64s staple	Composite 3/8"	I	21.78)		
		II	21.40)	0.38	1.40
	Composite $1\frac{1}{4}$"	I	21.70)		
		II	21.70)	0	0
56/58s staple	Composite 3/8"	I	26.35)		
		II	26.58)	.23	.77
	Composite $1\frac{1}{4}$"	I	26.98)		
		II	26.50)	.48	1.75
48/46s staple	Composite 3/8"	I	31.80)		
		II	32.38)	.58	1.74
	Composite $1\frac{1}{4}$"	I	32.30)		
		II	32.25)	.05	.14

[1] A "t" value of 1.96 is significant at the 5-percent probability level.

The grease wool making up each lot from which the core samples were drawn was scoured and carded at a commercial mill. Representative samples of card sliver were drawn from the carded wool of each lot. The card sliver samples were measured for fineness and variability. These findings were used as a control for the lot fineness, to verify fineness results obtained by using the 3/8-inch pressure coring tube and the $1\frac{1}{4}$-inch coring tube, and the results of the different plans used in subsampling the residual scoured cores.

The data in table 4 compare the average fiber diameter of the card sliver to the average fiber diameter of scoured core samples by subsampling plan, procedure for core-sampling, and by grade of lot. Differences in fineness are shown and these differences were tested for significance.

By comparing the differences in average fiber diameter of the card sliver and the various core samples, as presented in table 4, the largest difference was found to be 0.50 micron. The average difference of the 15 comparisons was 0.21 micron. Also, not one of the "t" values was significant at the 5-percent probability level.

It would appear that the differences in fineness or average fiber diameter that were found to exist between subsamples of the same residual scoured core sample and the differences in fineness between card sliver and the subsamples of the residual scoured core sample are not significant; therefore, based on the data in tables 3 and 4 there seems to be no reason to suppose that either of the two subsampling plans would give a more reliable result than the other.

Table 4.- Comparison of average fiber diameter of card sliver and scoured core samples by subsampling plan, procedure for core-sampling, and grade of lot

Grade of lot	Procedure for core sampling	Plan of sub-sampling	Average fiber diameter of core sample	Average fiber diameter of card sliver	Difference in average fiber diameter	t [1]
			Microns	Microns	Microns	
64s staple	Composite 3/8"	I	21.78	21.90	0.12	0.44
56/58s staple	Composite 3/8"	I	26.35	26.60	.25	.87
48/46s staple	Composite 3/8"	I	31.80	32.12	.32	.96
64s staple	Composite 3/8"	II	21.40	21.90	.50	1.88
56/58s staple	Composite 3/8"	II	26.58	26.60	.02	.07
48/46s staple	Composite 3/8"	II	32.38	32.12	.26	.76
64s staple	Individual 3/8"		21.76	21.90	.14	.65
56/58s staple	Individual 3/8"		26.61	26.60	.01	.08
48/46s staple	Individual 3/8"		32.40	32.12	.28	.82
64s staple	Composite 1¼"	I	21.70	21.90	.20	.73
56/58s staple	Composite 1¼"	I	26.98	26.60	.38	1.40
48/46s staple	Composite 1¼"	I	32.30	32.12	.18	.51
64s staple	Composite 1¼"	II	21.70	21.90	.20	.75
56/58s staple	Composite 1¼"	II	26.50	26.60	.10	.35
48/46s staple	Composite 1¼"	II	32.25	32.12	.13	.39

1/ A "t" value of 1.96 is significant at the 5-percent probability level.

Consequently, results from this preliminary study indicate that the sub-sampling plans requiring the least amount of time would be the preferred plan, namely, Plan I for the composite 3/8-inch pressure cores, and Plan I for the composite 1¼-inch cores.

The analysis of existing experimental data indicates that the size of coring tube used in drawing cores does not appear to influence fineness results; this fact, together with the close agreement in fineness between card sliver and subsamples of scoured cores, would suggest that the cores drawn for clean yield are adequate to estimate the fineness of a lot of graded grease wool.

Experiment with individual 3/8-inch pressure cores.—This phase of the study was set up to obtain estimates of variance in fineness between and within bales. The core-sampling pattern used for coring bales for clean yield could then be tested to ascertain its adequacy for determining fineness by using these variance values.

Five individual 3/8-inch pressure cores were drawn from each bale cored.
Ten bales of the 64s staple lot were cored and ten bales from the 56/58s
staple lot were cored. Two bales were cored from the 48/46s staple lot.
The cores were kept separate and fineness determinations were made on each
individual core.

Analysis of the data for within- and between-bale variance for the three
lots is depicted in figures 3, 4, 5, and 6, and tables 5, 6, and 7.

The within-bale variability for the 64s staple lot is partially portrayed
in figure 3. This control chart (5) shows the range found in fineness between
the finest and coarsest individual cores in each bale cored. It was noted
that the range for bale 49 fell outside the inner control line suggesting the
possibility that the bales differed in their internal variability. However,
Bartlett's test (6) did not show significant heterogeneity among the within-
bale variances even at the 10-percent probability level. So there was no
reason to suppose that the bales differed from each other in their internal
variability.

The between-bale variability is presented in figure 4, the control chart
for means. In this chart the average fineness for each bale is plotted and
the mean for the lot is shown. The average fineness of 5 of the bales falls
outside the inner control lines and 4 outside the outer control lines; thus
it is evident that there is a significant difference in fineness between bales.

An analysis of variance from the fineness data for the 64s staple lot is
given in table 5.

Table 5.- Analysis of variance for fineness, 64s staple lot

Source of variance	:	Degrees of freedom	:	Mean square
	:			
Between bales	:	9		6.39** 1/
Within bales	:	40		.66
Total	:	49		
	:			

1/ **indicates significance at the 1-percent probability level.

From the analysis it is established that the variance between bales is
significantly greater, 1-percent probability level, than the within-bale
variance.

The variance components observed in the original data consist of 1.15
microns because of differences between bales and 0.66 micron because of
variability within bales.

The control chart for ranges for the 56/58s staple lot is shown in
figure 5. It was observed that none of the ranges fell outside the inner
control line. This hints at the possibility that the bales do not differ in
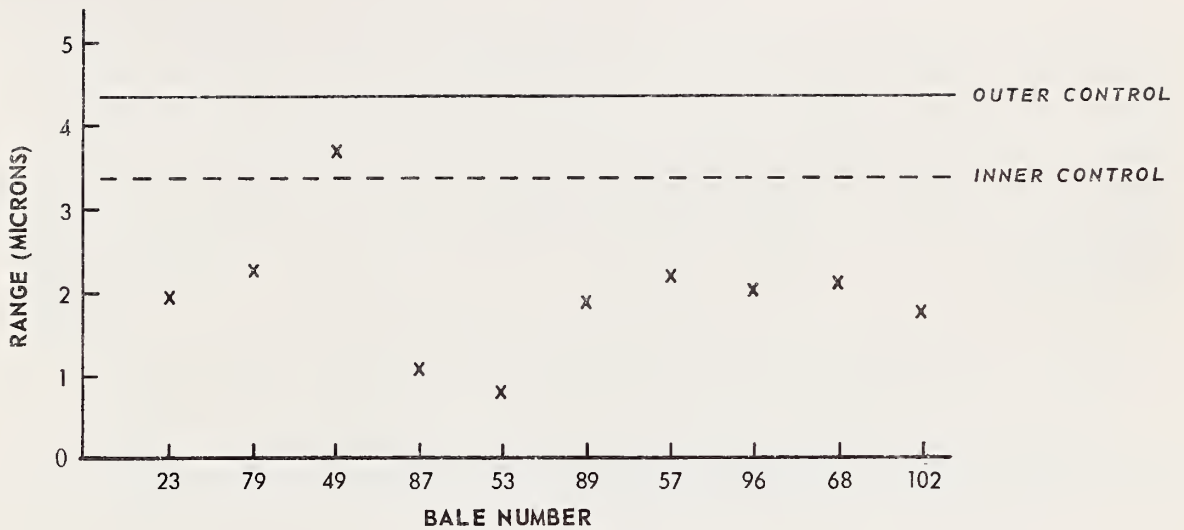their internal variability, and this supposition is supported by Bartlett's

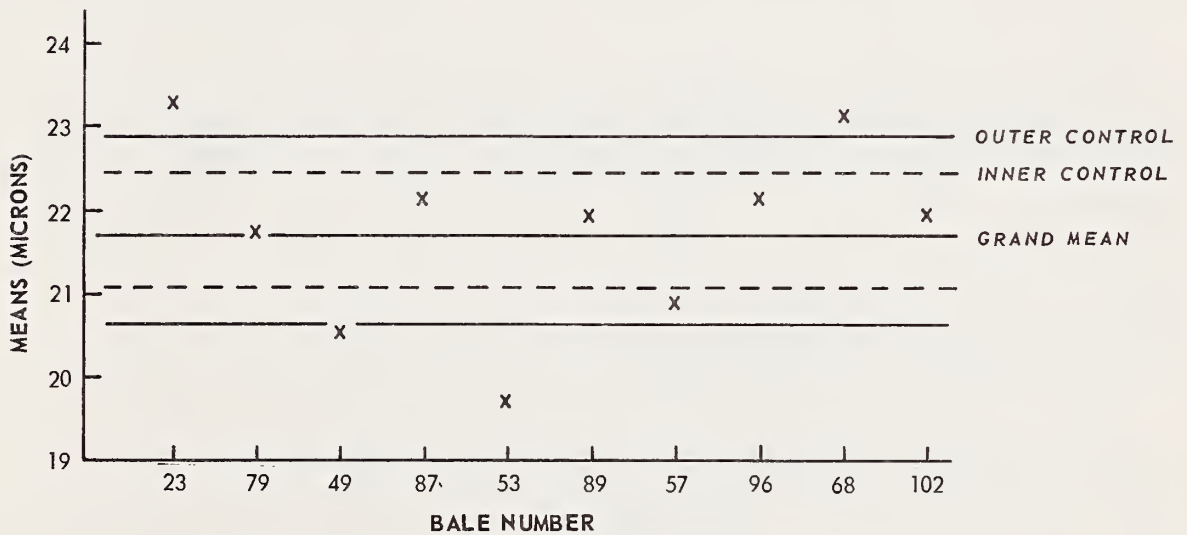FIGURE 3. -- CONTROL CHART FOR RANGES, 64s STAPLE LOT

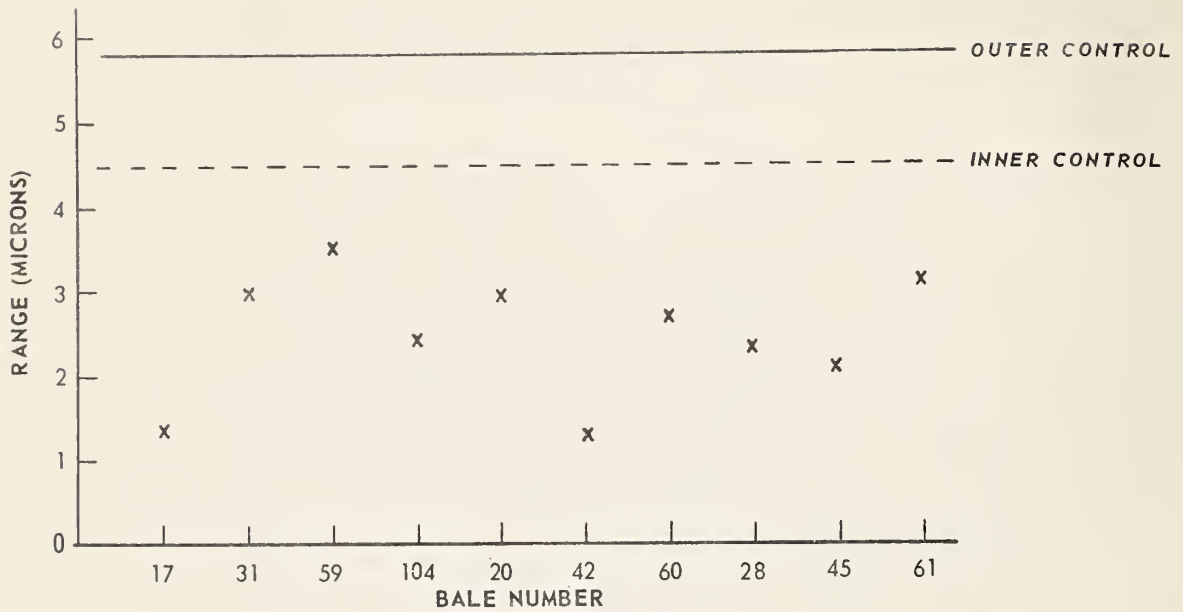FIGURE 4. -- CONTROL CHART FOR MEANS, 64s STAPLE LOT

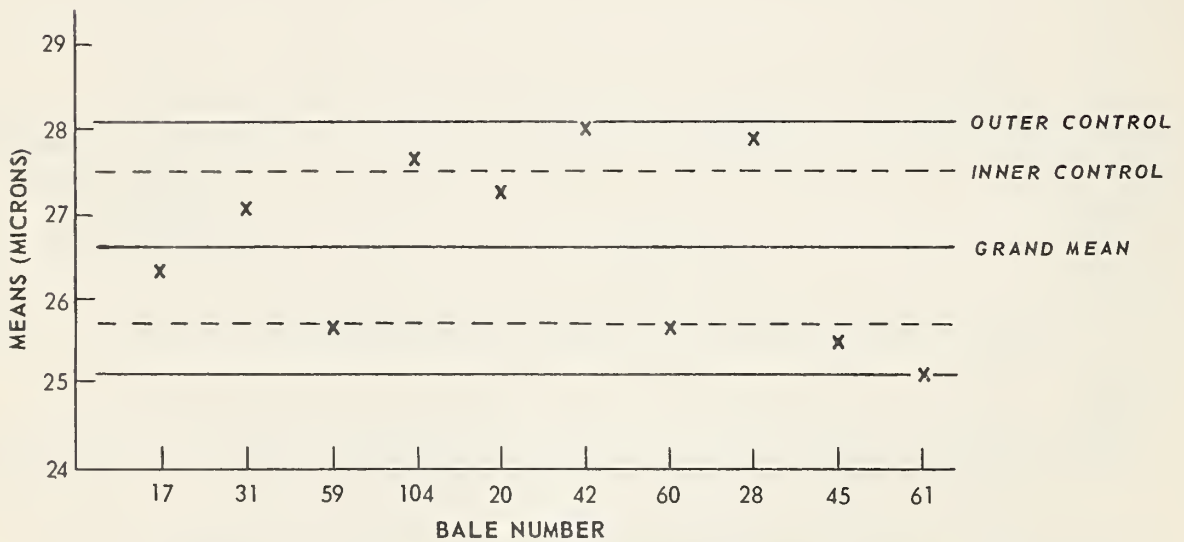FIGURE 5. -- CONTROL CHART FOR RANGES, 56/58s STAPLE LOT

FIGURE 6. -- CONTROL CHART FOR MEANS, 56/58s STAPLE LOT

test, which failed to show significant heterogeneity among the within-bale variances even when applied at the 10-percent probability level. Thus there is no reason to suppose that the bales differ from each other in their internal variability.

Figure 6 presents the control chart for means for the 56/58s staple lot.

Table 6.- Analysis of variance for fineness, 56/58s staple lot

Source of variance	:	Degrees of freedom	:	Mean square
Between bales	:	9		5.98** 1/
Within bales	:	40		1.08
Total	:	49		

1/ ** indicates significance at the 1-percent probability level.

The analysis established that the variance between bales is significantly greater, 1-percent probability level, than the within-bale variance.

The variance components observed in the original data consist of 0.98 micron because of differences between bales and 1.08 microns because of differences within bales.

There were insufficient data to prepare control charts for ranges and means for the 48/46s staple lot. The analysis of variance for fineness is given in table 7.

Table 7.- Analysis of variance for fineness, 48/46s staple lot

Source of variance	:	Degrees of freedom	:	Mean square
Between bales	:	1		1.50
Within bales	:	8		.64
Total	:	9		

The analysis established that between-bale variance is not significantly greater, 5-percent probability level, than within-bale variance for this lot.

The variance components observed in the original data consist of 0.17 micron because of difference between bales and 0.64 micron because of variability within bales. Only two bales were available for coring in this lot and the variance values are only relative values and should not be considered as reflecting the true variances one could expect from the grade.

With the between- and within-bale components of variance established, sampling schedules based on the variances found for the 64s staple lot and 56/58s staple lot were designed to show the number of bales to be sampled from a lot of a given size if a certain number of cores were drawn per bale;

these schedules are shown in tables 8 and 9 and were set up for a precision of plus or minus 0.5 micron at a 95-percent confidence level. The calculations followed a procedure and an equation described by the Standards Manual of the A.S.T.M. (4).

Table 8.- Sampling schedule for a precision of plus or minus 0.5 micron at a 95-percent confidence level, based on a within-bale component of variance of 0.66 and a between-bale component of variance of 1.15 microns

Number of cores per sampled bale	Number of bales in a lot									
	10	25	50	75	100	150	200	300	400	500
	Number of bales to be sampled									
	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales
1	10	15	20	22	24	25	26	26	27	27
5	7	12	15	16	17	18	18	19	19	19
10	7	11	14	15	16	17	17	18	18	18

The information in table 8 was based on a within-bale variance component of 0.66 micron and a between-bale variance component of 1.15 microns. Application of this table shows that if a lot were made up of 25 bales, the same sampling precision could be expected 95 times out of 100, if 1 core per bale were drawn from 15 bales, or 5 cores per bale from 12 bales, or 10 cores per bale from 11 bales.

Table 9.- Sampling schedule for a precision of plus or minus 0.5 micron at a 95-percent confidence level, based on a within-bale component of variance of 1.08 microns and a between-bale component of variance of 0.98 micron

Number of cores per sampled bale	Number of bales in a lot									
	10	25	50	75	100	150	200	300	400	500
	Number of bales to be sampled									
	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales	Bales
1	-	20	24	26	28	29	29	30	30	31
5	7	11	14	15	16	17	17	17	18	18
10	7	10	13	14	14	15	16	16	16	16

The data in table 9 were based on a within-bale variance component of 1.08 microns and between-bale variance component of 0.98 micron. Here the application shows that if a lot were made up of 25 bales the same sampling precision could be expected 95 times out of 100 if 1 core per bale were drawn from 20 bales, or 5 cores each from 11 bales, or 10 cores each from 10 bales.

The United States Department of Agriculture, Commodity Stabilization Service, under Instructions No. BN-721 (Wool)-2 revised 5-29-53, prescribed the procedure to be followed in taking core samples of wool for the determination of clean yield. Table 10 shows the number of bales to be cored and the number of cores to be taken per bale as set forth in these instructions.

Table 10.- Number of bales of wool to be cored and number of cores to be taken

Size of lot in bales	Bales to be cored	Cores per bale 1/	Total cores
Less than 10	All	(2/)	90
10 - 30	10	10	100
31 - 60	15	7	105
61 - 100	20	6	120
101 - 150	25	5	125
151 - 200	30	5	150
201 - 300	35	5	175
301 - 400	40	5	200
401 and over	50	4	200

1/ Cores drawn from the side of the bale using a metal tube with 1-inch cutting edge.

2/ Draw enough cores from each bale for a minimum of 90 cores.

Comparing the data in table 10 to that in tables 8 and 9, it would appear that samples drawn in accordance with the sampling schedule in table 10 would be adequate for the determination of fineness of the two lots upon which tables 8 and 9 were based.

The results obtained in the preliminary study pertaining to within- and between-bale variance components represent 3 lots of wool only, 1 of which was made up of only 2 bales. The information in tables 8 and 9, therefore, would be applicable only to lots with similar within- and between-bale variance components for fineness.

Variability in fiber fineness.—Table 1 shows the standard deviation and coefficient of variation for the various core subsamples and card sliver samples. These two statistical measures give values for the variability of fiber fineness within a test specimen. From a practical standpoint, the difference in variability caused by using coring tubes that differed in size was not significant. No practical difference was observed between the variability of subsamples of either the composite 3/8-inch pressure cores or the composite 1¼-inch cores. There was close agreement in fiber fineness variability between card sliver and subsamples of scoured cores.

SUMMARY

Preliminary investigations into the use of cores of wool drawn from bales of grease wool to determine fineness and variability are presented.

Core samples were drawn from bales selected from three lots of graded grease wool using a $1\frac{1}{4}$-inch diameter, motor-driven coring tube and a 3/8-inch diameter, pressure coring tube. Representative samples of card sliver were obtained and used as controls for lot fineness. Different plans of subsampling scoured core residues were studied. Fineness and variability measurements were made from all core and card sliver samples.

Difference in fineness between samples obtained using the 3/8-inch pressure tube and the $1\frac{1}{4}$-inch power-driven tube was not significant at the 5-percent probability level; therefore, for the samples tested in this study, the size of coring tube used in drawing cores does not appear to influence fineness results.

Differences in fineness or average fiber diameter between subsamples of the same residual scoured core sample were not significant at the 5-percent probability level. Likewise, in the comparison of the fineness of the card sliver with the fineness of the subsamples of the residual scoured core samples, the differences were not found to be significant at the 5-percent probability level. Consequently, for this study the subsampling plans requiring the least amount of time are the preferred plans, namely, Plan I for the composite 3/8-inch pressure cores, and Plan I for the composite $1\frac{1}{4}$-inch cores.

Another phase of the study was to obtain estimates of variance in fineness between and within bales. Five individual 3/8-inch pressure cores were drawn from each bale cored. The cores were kept separate and fineness determinations were made on each individual core.

Analysis of the data for within- and between-bale fineness variance for the three lots was made. The sampling schedules for baled grease wool now in use for the determination of clean yield are adequate for the estimation of the fineness and variability for the lots tested in this study. This is shown by application of the values for the between- and within-bale variance components for determination of the number of cores to be sampled per bale and the number of bales to be sampled for lots of various sizes, to obtain a precision of plus or minus 0.5 micron at a 95-percent confidence level.

Analysis of existing experimental data suggest that cores drawn for clean yield are adequate to estimate the fineness and variability of a lot of grease wool; however, since the cores tested were drawn from bales of graded grease wool, similar tests should be conducted on lots of graded grease wool which have been put up in bags.

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